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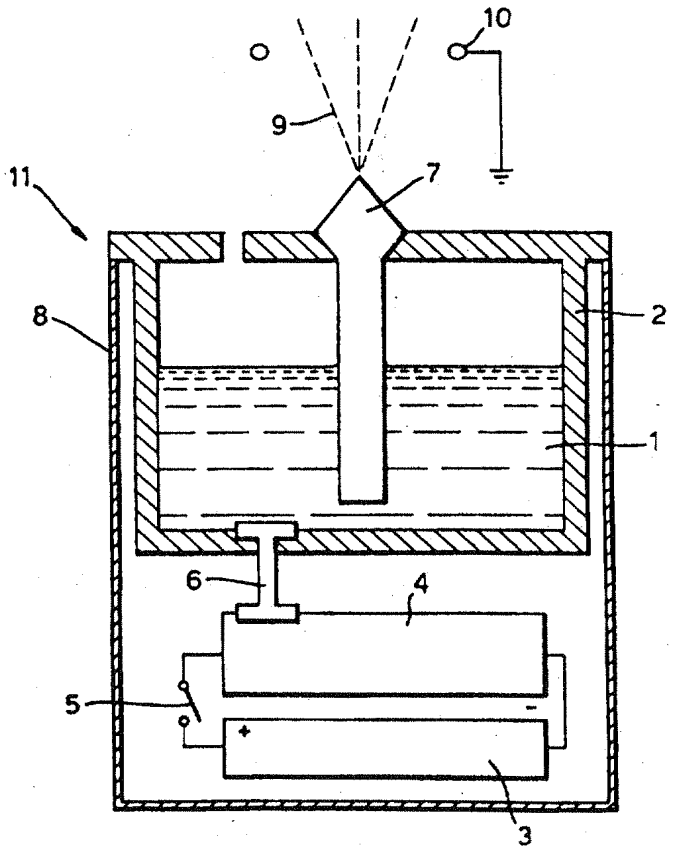
(57) Abstract

This invention relates to a distribution device (14) and method for distributing biologically active materials (1) into the atmosphere in aerosol form and an insect trap incorporating such a device. The device vaporises, volatilises or atomises the material in aerosol form using electrostatic techniques. The biologically active material (1) is typically an insect attractant or repellant and the device is used in insect trapping to lure insects to its source where a trap is provided or to ward off insects without using insecticides harmful to humans.



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DISTRIBUTION DEVICE

This invention relates to a distribution device for distributing biologically active materials into the atmosphere and a method and apparatus for trapping insects using the device.

Techniques for the liberation of chemicals into the air are well-known. They include the use of slow-release formulations, in which volatile compounds are released from surfaces, such as wicks, which retard or control the release rate, and the use of pressurised aerosol containers which offer an instant effect by manual activation of a pressure release valve.

Volatilisation rates of relatively involatile chemicals from an absorbent surface at ambient temperatures can be too low for many purposes. Aerosol containers can be used to atomise compounds resulting in high release rates. They are commonly used to distribute the atomised compounds within the confines of a room in order to achieve maximum effect of fragrance enhancement. The disadvantages are that the packaging of pressurised containers is expensive, they use large volumes of carrier gas, require filling under high pressure, the release rates are difficult to control, and the hydrocarbon gases which are commonly used as propellants are environmentally damaging.

The zone of activity of a volatile attractant or repellent released from a point source, the so called "active space", is dependent upon the release rate of molecules from that source. Once released into the air above the boundary layer, volatilised attractants or repellents are dispersed mainly by air currents which can carry them for many metres as a coherent plume, before turbulence destroys the coherence. Animals, such as insects, can thus be attracted upwind in an odour plume from distances extending to kilometres in appropriate conditions. In conditions of still air, such as occurs in the boundary layer close to any solid substrate, dispersion is mainly by diffusion leading to a concentration gradient

around the source. This concentration gradient can provide short-lived orientational cues to insects (and other animals), but usually only over distances of the order of a few centimetres. For effective distribution, a chemical compound or mixture must therefore be projected into the air above the boundary layer, where it will be carried further by the ambient air flow.

Many insect attractants, including pheromones, are relatively involatile and therefore attract insects at only very short range. An example is the sexual pheromone of the common housefly, Musca domestica, which is commonly used in synthetic form ("muscalure" or (Z)-9-tricosene) to attract houseflies to traps or toxic baits. The volatility is such that attraction occurs only over a distance of a few centimetres. Similarly, many insect repellents are effective only at close range.

According to one aspect of the present invention, a distribution device for distributing biologically active material into the atmosphere comprises means for vaporising, volatilising or atomising a material in aerosol form using an electrostatic technique, whereby the so vaporised, volatilised or atomised material is suspended in the atmosphere.

Thus the range of attraction can be extended by releasing the synthetic attractant into the air at a higher rate than occurs naturally so that it can be dispersed by air currents.

Preferably, the means for vaporising, volatilising or atomising a material in aerosol form for subsequent atmospheric suspension, comprise means arranged to subject the material to a sufficiently high electric field to cause the material to become electrically charged to a sufficient extent to enable atomisation of the material in aerosol form into the atmosphere for subsequent suspension therein.

Preferably, the device further comprises a substrate which is capable of having an electrical potential applied thereto and upon which the material to be vaporised,

volatilised or atomised is receivable, such that the material is electrically charged when subjected to the electric field generated by the electrical potential applied to the substrate.

The substrate may be in the form of a surface to which the material to be vaporised, volatilised or atomised is supplied, such surface preferably being pointed to enhance the electric field at its tip, when the electrical potential is applied.

Typically, the pointed substrate surface comprises one of an absorbent and a porous material.

The substrate may be electrically conductive or non-conductive and is preferably insulated from earth during use.

Alternatively, the material to be vaporised, volatilised or atomised may be subject directly to the electric field, whether or not any substrate is used.

In accordance with a second aspect of the present invention, insect trapping apparatus comprises a distribution device according to the first aspect of the invention and trapping means for trapping insects lured by the biologically active material, wherein the biologically active material is an insect attractant.

According to a third aspect of the invention, a method of distributing biologically active material into the atmosphere comprises vaporising volatilising or atomising the material in aerosol form using an electrostatic technique, whereby the so vaporised, volatilised or atomised material is suspended in the atmosphere.

Preferably, the electrostatic technique for vaporising, volatilising or atomising a material in aerosol form for subsequent atmospheric suspension, comprises subjecting the material to a sufficiently high electric field to cause the material to become electrically charged to a sufficient extent to enable the material to be atomised in aerosol form into the atmosphere for subsequent suspension therein.

According to a fourth aspect of the present invention a method of trapping insects comprises distributing a biologically active material into the atmosphere in accordance with the third aspect whereby a plume of biologically active material is produced along which insects orientate; and providing trapping means at the source of the plume whereby insects are attracted by the biologically active material and follow the plume to the trapping means to be trapped.

Preferably, the biologically active material is one of an insect attractant and an insect repellent.

In a preferred embodiment, the inventive apparatus and method are used to vaporise, volatilise or atomise liquids, in which case, a pointed substrate surface, preferably of an absorbent or porous material, may be employed. In this arrangement, an electrical potential applied to the liquid and/or surface creates an electric field which results in the liquid being electrically charged. As a consequence, the so-charged ionic species migrate to the tip of the point where the electric field strength is at its greatest and a meniscus is formed in the region of the tip. Eventually, the charge density of the ions at the so-formed meniscus becomes so great that the external electric field causes them to overcome the surface tension at the meniscus at which disruption occurs, so that the ions can move freely and, hence, be released from the remainder of the liquid in the region of the meniscus as an aerosol of charged droplets and into the atmosphere.

The depth of penetration of the aerosol spray into the atmosphere will depend upon such factors as the electrical potential applied to the liquid and/or substrate, the electrical conductivity of the liquid and the surface tension of the liquid at its meniscus. Subsequent "evaporation" of the charged droplets into, say, molecules can also occur, with corresponding charge transfer. The electric field can be adjusted to control the rate at which the aerosol is generated and, also to switch it "on"

and "off", if needs be.

The electrical charge may have either negative or positive polarity, and the level of charge may be determined by the electrical characteristics of the liquid or other material and the electrical energy input into the aerosol generating system. Liquid droplets or molecules that are atomised will, by virtue of their electrical charge, tend to interact with and become attached to airborne dust particles. This in turn imparts an electrical charge to any airborne dust within the aerosol treated area. Electrically charged particles are known to precipitate on to substrates more rapidly than uncharged particles.

The invention results in a more efficient and controllable method of releasing biologically active materials such as insect attractants and repellents into the atmosphere for suspension therein. With the invention, vaporisation, volatilisation or atomisation of a material, such as a liquid, may be achieved by electrostatic field enhancement. This offers a number of important advances over existing technology. In the first instance, no propellant gas is necessary. Secondly, the electrostatic release of the material into the atmosphere offers more control over the aerosol characteristics. Thirdly, the aerosol created will carry an electrical charge and as a result will affect the distribution of dust particles in the air.

Further, the invention includes a controlled release device or method for releasing into the atmosphere in aerosol form biologically active material such as insect attractants and repellents for subsequent airborne suspension, which device or method incorporates any form of inventive apparatus or method defined above or otherwise described herein. This allows materials to be used to attract insects to a trap or ward them off a particular area without needing to disperse insecticides or other chemicals which could be harmful to humans or other

animals. The insect trap of the present invention allows these harmful products to be restricted to the trap.

It is to be appreciated that the presently inventive apparatus and method are distinguished from known electrodeposition coating processes using electrostatic techniques, in that they release into the atmosphere an aerosol whose particles or droplets are subsequently suspended therein, whereas in known electrostatic deposition processes, particles are subsequently, and usually immediately, deposited on a substrate.

An example of a distribution device and trapping apparatus according to the present invention will now be described with reference to the accompanying drawings in which:-

Figure 1 illustrates a distribution device according to the invention;

Figure 2 illustrates trapping apparatus incorporating the device of Figure 1;

Figure 3 is a graph of distribution of houseflies with time with no attractant present;

Figure 4 is a graph of distribution of houseflies with time with attractant introduced by conventional means; and,

Figure 5 is a graph of distribution of houseflies with time with attractant introduced using the device of Figure 1.

In the device of figure 1 a supply of liquid 1 to be atomised is contained in a chamber 2 made of an electrically insulating material. The chamber 2 also contains a pointed wick 7 of absorbent or porous material, which is electrically insulating and which becomes saturated by the liquid 1 as a result of capillary action. The chamber 2 is located in a case 8 preferably also of electrically insulating material, which contains a battery 3 as a power supply, connected to a voltage multiplying circuit 4. Above the pointed wick 7 is an electrode 10, connected to ground.

A switch 5 actuates the power source battery 3 and an electrical contact 6 connects the voltage output to the liquid chamber 2. Subject to its electrical resistivity, the liquid 1 in the chamber 2 and within the wick 7 attains the same electrical potential as the voltage of the multiplying circuit 4. The electrode 10 is the reference point for the voltage output, so that a high electric field is produced between the pointed wick 7 and the electrode 10.

The liquid 1 becomes electrically charged and the so-charged liquid ions migrate to the tip of the wick 7 where the electric field strength is greatest, resulting in the formation of a liquid meniscus at the wick tip. The charge density of the ions at the so-formed meniscus becomes so great, due to electric field enhancement thereat, that the electric field causes disruption and deformation of the meniscus so that the ions can move freely and, hence, overcome the surface tension of the liquid at the meniscus. As a result, the ions are released from the remainder of the liquid in the region of the meniscus at the wick tip as an aerosol spray of charged liquid droplets and into the atmosphere. Such atomisation of the liquid 1 into a fine aerosol spray 9 with each liquid droplet carrying an electrical charge causes them to be suspended in the atmosphere. The charged liquid droplets move away from the wick tip. In the process the charged droplets collide with neutral air molecules in the vicinity imparting momentum to the air molecules, thereby inducing an air flow. The induced air flow assists the charged droplets in moving away from the wick tip in the shape of a plume. In this example the electrode 10 is in the form of a toroid. This is preferred because it allows the aerosol plume to pass through it without affecting the shape of the plume unduly. Although a flat plate electrode would serve the purpose of providing a reference point, the plume would be diverted.

The polarity of the charge imparted can be either

positive or negative according to requirements. The electrical supply can be mains or battery and can be selected to achieve different release rates of liquid. The porosity of the wick 7 can also be selected to achieve different release rates. The geometry of the wick can be modified to direct the spray in any desired direction. The wick may consist of a single capillary or a device can be constructed with a series of separate wicks. The voltage may also be adjusted to maintain a liquid meniscus surface of constant diameter at the tip of the wick,without aerosol production, which would be a means of controlling the release rate of the liquid or other material within precise limits.

The aerosol may also be electrically charged by means of a natural charge exchange phenomenon occurring during normal valve decompression in pressurised aerosol containers. This charge may be controlled by modification of the valve design and/or formulation of the product so as to enhance charge exchange. Once charged, the aerosol would then have the same dust removal characteristics as the purely electrostatic atomising system described above. The invention is particularly useful with relatively involatile biologically active chemicals, such as certain pheromones and other insect attractants and repellents.

Figure 2 shows an example of insect trapping apparatus according to the invention. A conventional electrical fly killer 11 consisting of an electrical grid 12 over strip lights 13 is provided with a distribution device 14 from which a plume 15 of biologically active material, typically an attractant, is emitted and dispersed by the induced air flow generated by the device itself as described above.

Thus, by using the device of the present invention, the attractant is carried so that insects are drawn towards the fly killer from a distance rendering the fly killer more efficient in removing flies. The principle of using the distribution device in combination with a conventional trap can clearly be applied to other forms of trap and

other insects if the correct attractant is used. Similarly, if it is desired to ward off insects from a particular area, then a distribution device can be suitably positioned and a repellant used instead of an attractant.

An example of experiments into the effect on the distribution of houseflies in a particular area for given conditions is described below. The conditions were

(i) no attractant was used (Figure 3);

(ii) attractant used was distributed by conventional means (Figure 4); and,

(iii) attractant used was distributed using the device of the present invention (Figure 5).

The experimental data was obtained by releasing 30 houseflies into a wind tunnel having dimensions of 1.2m long and 28cm in diameter. The tunnel was further sub-divided into six sectors of equal length where sector 6 was closest to a source of attractant and sector 1 was furthest from it and downwind.

Figure 3 shows the varying distribution of the house flies over a 30 minute period with no attractant being emitted from the source and air passing from sector 6 to sector 1 at a speed of 0.1 ms^{-1}. The number of flies close to the source (sector 6) has reduced and the number of flies furthest from the source (sector 1) has increased so that at the end of the 30 minute period the majority of flies are in sector 6.

Figure 4 shows how the distribution varies if an attractant is put into the air by conventional means. In this case the number of flies in sector 1 tends to decrease and the number of flies in sector 6 decreases more slowly over the first 25 minutes. Only at the end of the measured period does the number of flies in sector 6, i.e. close to the source start to increase.

Finally, Figure 5 illustrates the effect on distribution of houseflies of introducing attractant using the device of the present invention in 10 second bursts every minute. From the outset the majority of flies are

found in sector 6 and with time this increases, indicating the significant improvements in efficiency of introducing the attractant as an aerosol using an electrostatic technique.

CLAIMS

1. A distribution device for distributing biologically active material into the atmosphere comprising means for vaporising volatilising or atomising the material in aerosol form using an electrostatic technique, whereby the so vaporised, volatilised or atomised material is suspended in the atmosphere.

2. A device according to claim 1 wherein the means for vaporising, volatilising or atomising the biologically active material in aerosol form for subsequent atmospheric suspension, comprises means arranged to subject the material to a sufficiently high electric field to cause particles of the material to become electrically charged to a sufficient extent to enable them to be released from the remainder of the material in aerosol form into the atmosphere for subsequent suspension therein.

3. A device according to claim 1 or claim 2 further comprising a substrate which is capable of having an electrical potential applied thereto and upon which the material to be vaporised, volatilised or atomised is receivable, such that particles of the material are electrically charged when subjected to an electric field generated by an electrical potential applied to the substrate.

4. A device according to claim 3 wherein the substrate is in the form of a surface to which the material to be vaporised, volatilised or atomised is supplied.

5. A device according to claim 4 wherein the surface is pointed to enhance the electric field at its tip, when the electrical potential is applied.

6. A device according to claim 5 wherein the pointed substrate surface comprises one of an absorbent and a porous material.

7. Apparatus according to any of claims 3 to 6 wherein the substrate is electrically conductive.

8. Apparatus according to at least claim 2 wherein the material to be vaporised, volatilised or atomised is subject directly to the electric field, whether or not any substrate is used.

9. A device according to any preceding claim wherein the biologically active material is one of an insect attractant and an insect repellant.

10. Insect trapping apparatus comprising a distribution device according to any of claims 1 to 8, and trapping means for trapping insects lured by the biologically active material, wherein the biologically active material is an insect attractant.

11. A method of distributing biologically active material into the atmosphere comprising vaporising volatilising or atomising the material in aerosol form using an electrostatic technique, whereby the so vaporised, volatilised or atomised material is suspended in the atmosphere.

12. A method according to claim 11 whereby the electrostatic technique for vaporising, volatilising or atomising the biologically active material in aerosol form for subsequent atmospheric suspension, comprises subjecting the material to a sufficiently high electric field to cause particles of the material to become electrically charged to a sufficient extent to enable them to be released from the remainder of the material in aerosol form into the

atmosphere for subsequent suspension therein.

13. A method according to claim 11 or claim 12 wherein the biologically active material is one of an insect attractant and an insect repellant.

14. A method of trapping insects comprising distributing a biologically active material into the atmosphere in accordance with the method of any of claims 11 to claim 13 whereby a plume of biologically active material is produced along which insects orientate; and providing trapping means at the source of the plume whereby insects are attracted by the biologically active material and follow the plume to the trapping means to be trapped.

Fig.1.

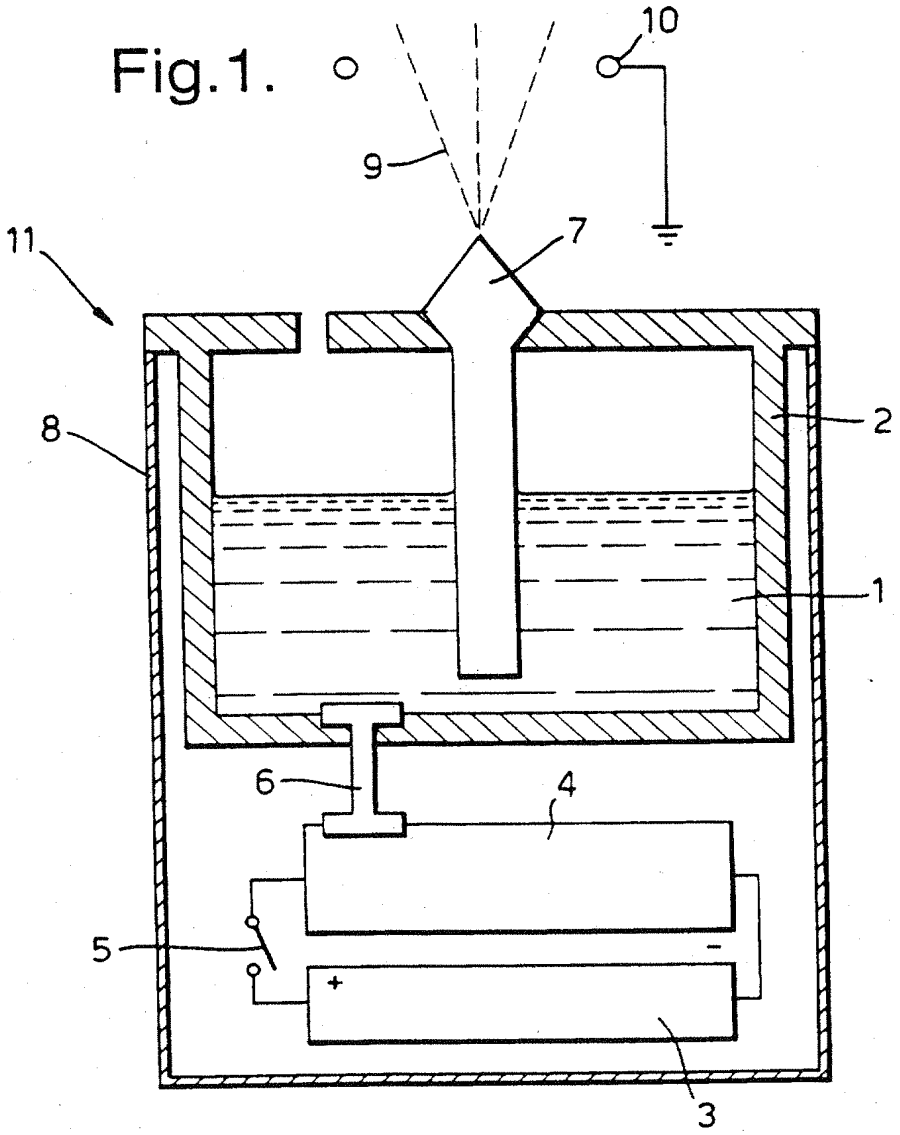


Fig.2.

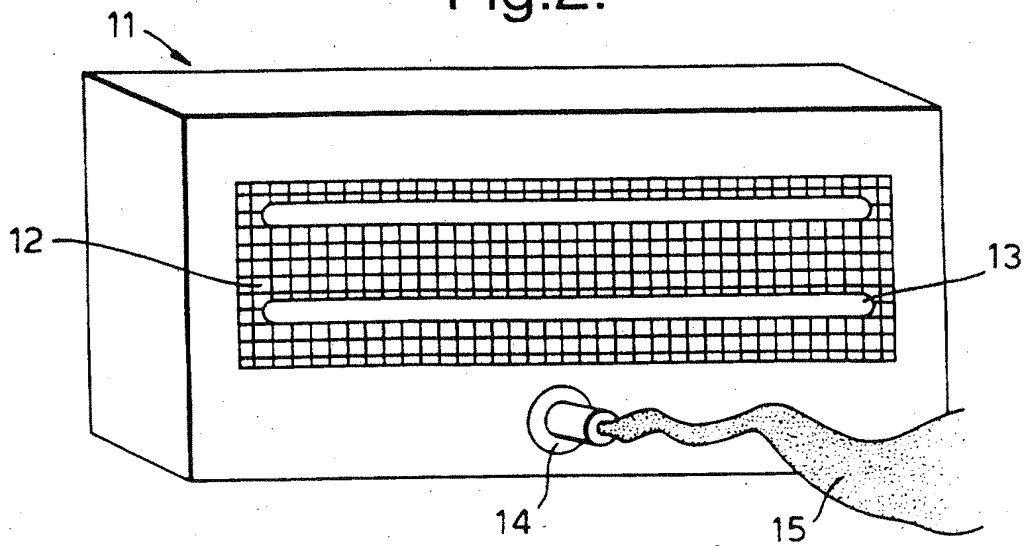


Fig.3.

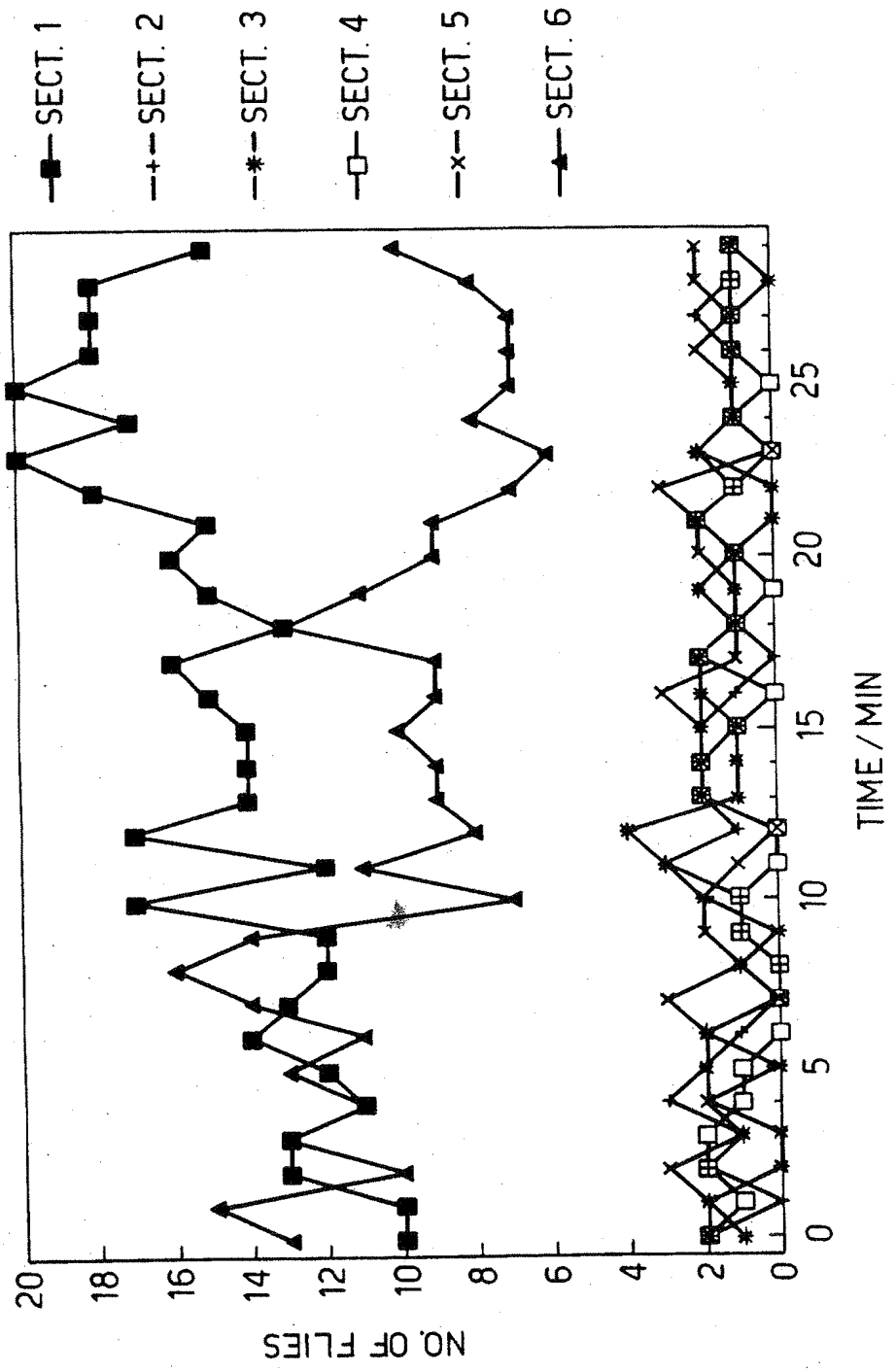


Fig.4.

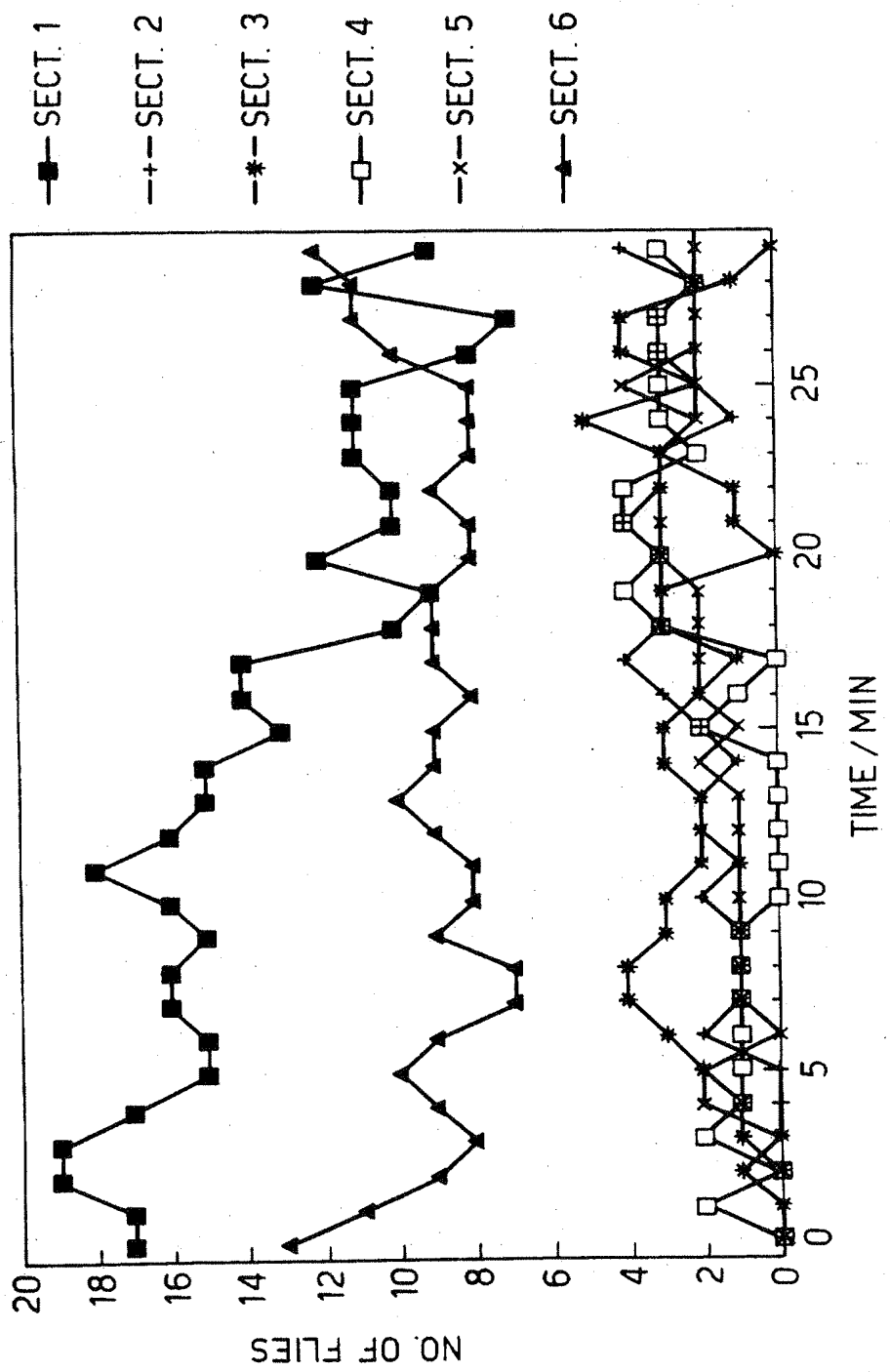
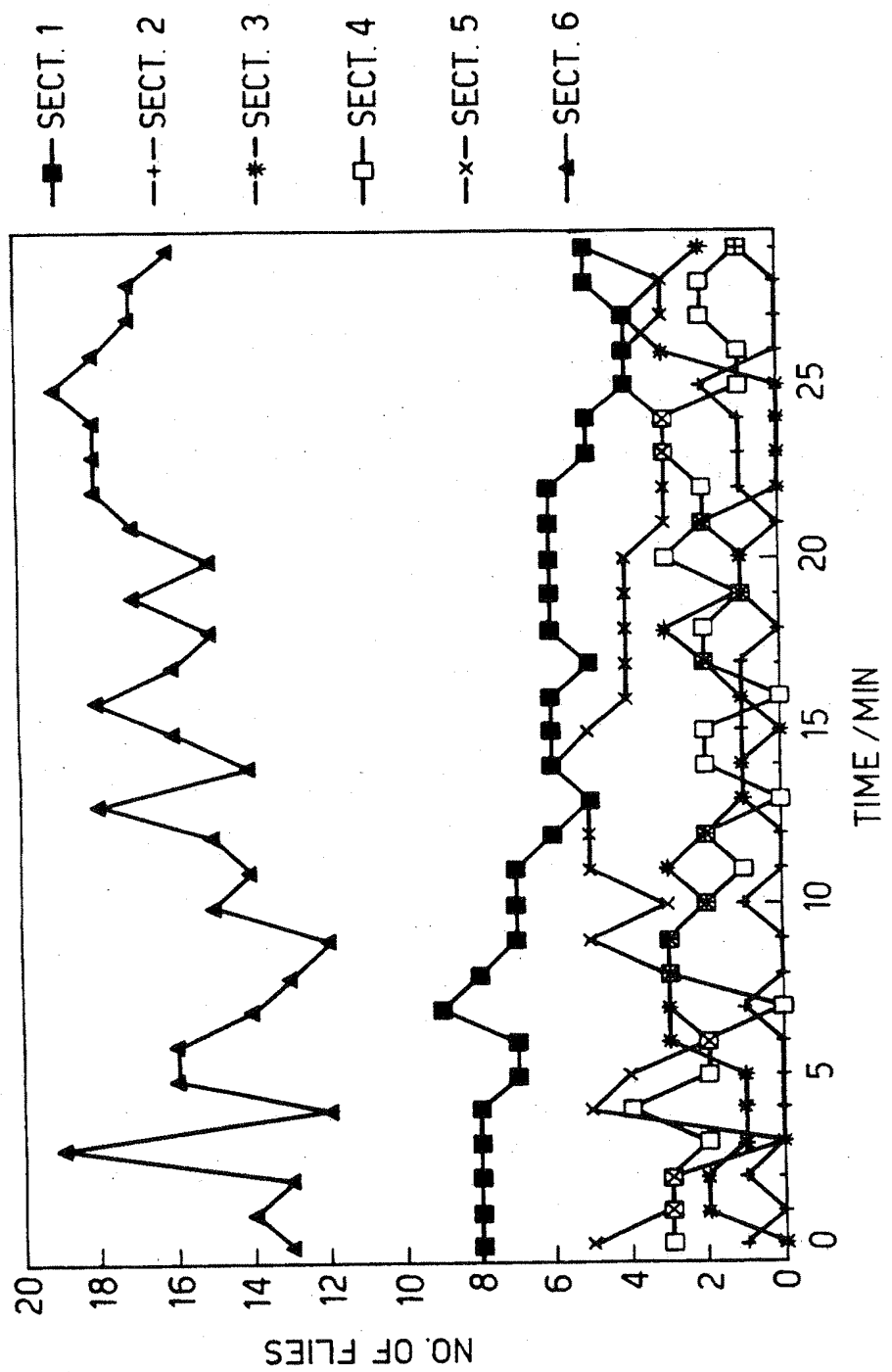


Fig.5.



INTERNATIONAL SEARCH REPORT

Inten al Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A01M1/20 A01M1/22 A61L9/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A01M A61L B05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,5 196 171 (PELTIER) 23 March 1993 see column 2, line 28 - column 3, line 44 see column 4, line 23 - column 6, line 68 see claims; figures ---	1-9, 11-13
X	EP,A,0 243 031 (IMPERIAL CHEMICAL INDUSTRIES) 28 October 1987 see page 1, line 15 - line 23 see page 3, line 5 - line 23 see page 13, line 22 - page 14, line 7 see claims; figures ---	1-9, 11-13
X	US,A,4 776 515 (MICHALCHIK) 11 October 1988 see column 2, line 32 - column 4, line 26 see claims; figures --- -/--	1-5,8, 11,12

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR,A,1 009 980 (VADOT) 5 June 1952 see page 1, column 1, paragraph 1 see claims; figures	1,9,13
A	WO,A,82 00079 (MITCHELL) 21 January 1982 see claims; figures	1,10,14
A	DE,A,33 32 449 (ERNST ROEDERSTEIN SPEZIALFABRIK FÜR KONDENSATOREN GMBH) 21 March 1985 see claims; figures	1,9,13

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